WATER

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NEARLY every community has a water problem. One-fourth the population today is troubled with water shortage, poor water, or both. And the prospects are for even more difficulty in the future.

Why this growing concern over water?

Is there less water than formerly? Or are we simply using more?

Where do we begin to cope with the water problem?

Where does our water come from?

Precipitation (rain, snow, hail, sleet) is the source of our water supply.

The "water cycle"—from clouds in the sky to land and ocean and back to the sky again—constantly renews the water supply.

As water falls upon the ground, some runs off over the surface, some is held in the soil, and some percolates to ground water.

Water in the soil is used to grow crops, pastures, forests, and all the other vegetation that covers the land. In the aggregate, about 70 percent of the national water supply is transpired by plants or evaporates directly from the soil or other surfaces.

Surface runoff and ground water supply direct human needs in homes, industries, irrigation, recreation, etc. Nationwide, about 80 percent comes from surface sources and 20 percent from ground water.

Watersheds divide the supply

The water cycle does not bring the same amount of water to all communities.

Precipitation is not spread evenly over the country. It ranges from 120 inches a year along the Northwest coast to less than 5 inches in the arid Southwest.

Within a region, the water that falls is divided into separate portions by watersheds. A watershed is any area of land that drains into a particular stream or body of water.

Each community depends upon the insoak and runoff of its own watershed. Once on its downhill course, water cannot cross watershed divides, although some ground water may pass beneath watershed boundaries.

Water problems, therefore, are local problems. They arise because the water supply of a watershed does not match the demands of its people and industries.

Some communities, of course, arrange to tap the supplies of other watersheds. But, by and large, problems of water shortage, floods, pollution, or sedimentation must be met within the confines of each watershed.

Land influences water supply

Since lakes and streams occupy less than 2 percent of the country's area, about 98 percent of the precipitation must fall on land surfaces.

Whether the water enters the ground or runs off overland depends largely upon the nature and condition of the soil and its vegetative cover.

Also, the capacity of the soil to store water within reach of plant roots varies with soil type and condition.

What happens to precipitation, therefore, is greatly influenced by the management of watershed lands.

The farmers and ranchers who control our farmlands, rangelands, and woodlands also control to an important degree the movement of the water that falls on their land.

How much water?

There is just so much water. Except for negligible amounts newly created or destroyed by chemical changes, the earth's water supply remains constant.

Average annual precipitation in the United States is about 30 inches. This amounts to about 4,300 billion gallons a day. That is our total water supply.

Total streamflow derived from surface runoff and ground water amounts to about 8.5 inches a year, or about 1,200 billion gallons a day. That

is the potential sustained supply for direct human use. It is about 6 times the average daily use now, 4 times the predicted requirements in 1975.

Surface water supplies

Streams, reservoirs, and lakes are the major source of available water. They supply about 75 percent of the water used by cities and towns and by farmers for irrigation, 90 percent of the fresh water used by industry, and nearly all of that used for hydroelectric power.

Reservoirs store floodwater until it is needed for useful purposes.

More than 10,000 reservoirs larger than farm ponds have been constructed in the United States. In 1954 there were 1,300 reservoirs larger than 5,000 acre-feet capacity with a combined surface area of more than 11 million acres. These larger reservoirs could store 278 million acre-feet of water—more than 20 percent of the annual streamflow.

In addition there are countless smaller lakes and ponds. The Soil Conservation Service estimates that farmers and ranchers had built more than 1¼ million ponds with Federal assistance by the end of 1955. The average size of these ponds is about 2 acre-feet.

Land use has greatly changed the flow regimen of many streams. Deforestation, urbanization, bad farming practices, and range abuse increase surface runoff during rains.

Total annual streamflow from large river basins seems to be little changed by land use. But the timing, the size of peak flows, and the portions of streamflow derived from surface runoff and from ground water may be greatly altered.

These changes aggravate water shortages during dry seasons and flood hazards during wet ones.

Ground water

Underground reservoirs contain more fresh water than all surface reservoirs and lakes combined, including the Great Lakes. Ground water is estimated to equal 10 years' average rainfall or 35 years' average runoff.

About one-sixth of all the water used in the

United States comes from underground sources. Most ground water is part of the water cycle. In many areas ground water is being used faster than it is naturally replenished. In effect, the stored water is being "mined;" water levels in wells are dropping, and the irrigation projects, municipalities, and industries depending on them are threatened.

We are using more water

While the potential supply of water after transpiration and evaporation remains constant, needs for human use pyramid with growing population. Expanding industry and rising standards of living require more water per person to satisfy the American way of life.

From 1900 to 1950, while United States population doubled, total water use, other than for power, increased fourfold. By 1955 it was up another 21 percent from 1950.

Water needs are expected to double again by 1975, while population increases 40 percent.

Average daily use for all purposes increased from 600 gallons per capita in 1900 to 1,100 gallons in 1950 and 1,300 in 1955. By 1975 the country will be using 1,800 gallons of water a day for every man, woman, and child.

What we use it for

Industry and irrigation take most of the water withdrawn from primary sources. National estimates for major uses in billions of gallons per day are as follows:

	1950	*1955*		*1975*	
	Withdrawals	*Withdrawals*	*Percent of 1950*	*Withdrawals*	*Percent of 1950*
Municipal	14.0	17.0	121	20	135
Rural domestic	3.6	2.5	69	5	140
Irrigation	79.0	81.0	103	110	139
Industry	77.0	110.0	143	215	279
Total	173.6	210.5	121	350	202

It is estimated that less than half, perhaps about 40 percent, of withdrawn water is "consumed;" i. e., incorporated into a product or evaporated.

From 60 to 95 percent of municipal water, 90 percent of industrial water, and 30 to 40 percent of rural domestic and irrigation water are returned to surface or underground storage.

Use of water for power is nonconsumptive.

Most nonwithdrawal uses are also nonconsumptive, although there is loss by evaporation from bodies of water provided for these purposes.

Water for cities and towns

Cities and towns are using more water every year. Average per-capita use has increased from 95 gallons a day in 1900 to 145 gallons in 1950 and 148 gallons in 1955.

Per-capita use varies widely from one community to another. It ranges from 60 gallons a day in towns of 500 population to 150 gallons or more in cities of 100,000 and more. Some large industrial cities use as much as 300 to 500 gallons per person per day.

The 1950 average daily per-capita use of 145 gallons was divided approximately as follows: Residential, 50 gallons; industrial, 50 gallons; public (fire fighting, street washing, etc.) 10 gallons; commercial, 20 gallons; loss (through leaks, breaks, etc.), 10 gallons; other, 5 gallons.

About three-fourths of this water comes from streams and lakes, about one-fourth from ground water.

Water for rural homes and livestock

Rural water comes from private sources. There is no record of the amount used, as for municipal systems. The quantity can only be estimated from population figures and average requirements.

On this basis, it is estimated that in 1955 rural homes used about 2.5 billion gallons a day. About three-fourths was from wells and springs.

Rural domestic water needs are figured at 50 gallons per person per day in homes with running water, and 10 gallons per day for those without.

Livestock water needs are figured at 15 gallons per animal per day for milk cows; 10 gallons for other cattle, horses, and mules; 4 gallons for hogs; 3 gallons for sheep and goats; and 0.2 to 0.4 pint for poultry.

Water for irrigation

Irrigation is the Nation's greatest consumptive use of water.

Farmers withdraw for irrigation nearly 5 times as much water as municipalities and three-fourths as much as industries use. Most irrigation water is evaporated or transpired by crops. As a result, irrigation probably consumes more than 3 times as much water as all other uses combined.

Irrigators used 91 million acre-feet of water on about 34 million acres of crops in 1955. More than 70 percent of this water was from surface sources; about 30 percent from ground water.

This amounted to an average of 81 billion gallons a day although its use was not uniform throughout the year. Crops must be watered primarily during their season of growth, usually only a few months or even weeks.

The seasonal need for irrigation water often puts a strain on local supplies, even where the total quantity would be adequate if its use could be spread over the entire year.

Water for industry

Water is industry's No. 1 raw material. In 1950 industry used from private sources nearly 120 billion tons of water—almost 50 times the weight of all other industrial materials.

These figures do not include water drawn from public water systems, nor water used to generate power.

More than 90 percent of industrial water comes from surface supplies, the rest from ground water.

About 65 percent of industrial water is used by steam-electric generating plants, mainly for condenser cooling. The rest is used primarily for manufacturing and processing.

Manufacturing uses tremendous volumes of water. For some products as much as 300 pounds of water is required for each pound of finished product.

The average manufacturing plant uses roughly one-fourth its water for cooling, one-fourth for sanitary and service purposes, one-eighth for boiler-feed, and three-eighths for processing its products.

The amount of water used for any product varies widely, according to the process used, efficiency of the plant, the degree to which water is recirculated, and other factors. Following are ranges reported by individual plants in some major industries:

Product	*Water used, gallons*
Steam-generated electricity per M kw-hr	52,000 to 170,000
Refined petroleum (processed crude), per M barrels	151,000 to 15,000,000
Rayon yarn, per ton	250,000 to 403,974
Woolen cloth, per M yard	40,000 to 510,000
Rolled steel, per ton	6,000 to 110,000
Paper and pulp, per ton	55,000 to 80,000
Paperboard, per ton	7,692 to 86,000
Cane sugar, per ton	4,000 to 110,000

The trend toward synthetic and more highly refined products, as well as the rapid expansion of industry, calls for increased water supplies.

On the other hand, many plants can reduce their water intake by using other types of cooling systems or by recirculating and reusing water.

The local abundance or scarcity of water and the economics of installing and operating water-conserving equipment largely determine the practices used at each plant.

Water for power

More water is withdrawn from streams and reservoirs to generate power than for all other uses combined. An average of 1,500 billion gallons a day was withdrawn for waterpower in 1955, more than 7 times as much as for all other purposes.

But practically all this water is returned to the streams. Usually its quality is not changed, except for increase in temperature. This use ordinarily does not materially reduce the supply of water for other purposes.

Water for recreation and wildlife

Water is the key element in many kinds of recreation. It is indispensable to wildlife, which itself is valuable to recreation.

Water is neither withdrawn nor consumed when used for recreation or wildlife habitat, although some is lost by evaporation and seepage. But the withdrawal and consumptive uses, such as irrigation and industry, often reduce the supply or diminish the value of water for recreation and wildlife.

The supply and use of water for recreation and wildlife cannot be measured in gallons, as for withdrawal uses. Rather, the availability and character of lakes, streams, and other bodies of water to meet the needs in each location are the crucial matters.

Fish, waterfowl, and many other kinds of wildlife require suitable aquatic habitats for propagation and survival.

Some other uses

Transportation of bulk freight by water is important to many industries and cities. About 40 billion ton-miles of freight move annually on inland waterways.

Streams also serve a valuable function in waste disposal. Growing cities and industries, however, have overloaded many streams with sewage and other wastes and created serious pollution of water supplies.

Water losses

Local water shortages arise in part from losses that keep some of the potential supply from being put to beneficial use.

Flash runoff robs communities of part of their natural water resource. Peak flows that exceed storage facilities are an economic loss, aside from the damage they do as floods.

Sedimentation that reduces storage capacity, evaporation that dissipates stored water, and pol-

lution that makes water unfit for certain uses all reduce the usable supply.

Sedimentation.—Sediment carried into ponds and reservoirs by flowing water gradually fills their storage basins. In 1950 the average loss to the Nation's reservoirs was estimated at 350,000 acre-feet annually.

Individual reservoirs commonly lose from a fraction of 1 percent to more than 3 percent of their storage capacity annually. Ponds may fill up more rapidly.

Reservoirs lose most of their value when they are 50 to 80 percent silted. Sediment also fills harbors, canals, and rivers, where it interferes with navigation and detracts from their value for recreation and fish life.

Sedimentation is most serious in watersheds with much unprotected land where erosion is active.

Pollution.—In 1950, 11,800 municipal sewer systems and 10,400 independent factory-waste outlets were discharging into public waters. Only 6,700 of the sewage plants and 2,600 of the industrial plants gave adequate treatment to the wastes.

More than 2,000 industries discharged inorganic wastes, such as acids and poisonous chemicals. In addition, drainage from abandoned coal mines poured 10,000 tons of acid pollution into waterways daily.

Thus, although cities and industries return nearly 90 percent of the water they use to natural sources, some of the water may be largely worthless for reuse.

Problems of too much water

Too much water at the wrong time may be as serious as too little.

Hardly a year goes by without a disastrous flood somewhere in the United States.

The average annual damage from floods in the United States is about $1 billion. About 56 percent of this occurs on the upstream tributaries and 44 percent in the downstream valleys.

Most of the damage on the headwater streams—about 70 percent—is agricultural.

Most of the downstream flood damage is to residences, industrial and business property, and transportation and utility facilities. Even so,

about a third of the damage in large valleys is to rich agricultural land of the flood plains.

Floods can be reduced by soil and water conservation on the farmlands, forests, and ranges that make up the watersheds and by water-control structures on the upstream channels.

Floods can be further controlled by large downstream dams, dikes, and other structures to protect cities, towns, and urban property, and agricultural land on the downstream flood plains.

Both upstream and downstream measures are encouraged by the Federal Government.

Drainage.—Drainage of wet land has been a necessary step in much of the settlement and agricultural development of America.

Nearly a fourth, or about 216 million acres, of the Nation's potential agricultural land was originally too wet for farming. About 67 million acres, or a fifth of the present cropland, needs improved drainage.

Only about half of land drained for agriculture was actually covered with water most of the time before drainage. Rather, the soils were waterlogged or occasionally dotted with transitory pools that interfered with cropping.

Naturally, the best and most easily improved land was drained first. Nevertheless, some land drained for agricultural purposes was later found to be unsuitable for crop or pasture production. New drainage work needs to be carefully planned within the known capability of the land. Wildlife and recreational values also need to be safeguarded.

Watershed protection and conservation

Water problems in the last analysis are watershed problems.

It is within separate watersheds that communities can manage their water resource to best meet their own needs.

This takes teamwork. All the people must plan and act together to make the best use of all the land and water resources. Water control and conservation cannot be separated from soil conservation.

Rural and urban interests all over the country are joining in small watershed-protection and flood-prevention projects that deal with all aspects of land and water conservation. Local,

State, and Federal agencies cooperate in planning, financing, and carrying out projects under the Watershed Protection and Flood Prevention Act (Public Law 566, 83d Cong., as amended by Public Law 1018, 84th Cong.).

These projects combine soil and water conservation on the land with control and use of runoff by means of upstream structures in small watersheds. Improvements for industrial and municipal supplies or wildlife and recreational facilities can be included at local expense.

Small watershed projects are initiated by local organizations, such as soil conservation districts, municipalities, counties, or watershed associations.

The Soil Conservation Service has administrative leadership for the Department of Agriculture's part in these projects.

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